NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

February 10, 2013

FIRE INVESTIGATION FACTUAL REPORT Report No. 13-014

A. ACCIDENT INFORMATION

Place	:	Boston, MA
Date	:	1/7/2013
Vehicle	:	Boeing B787, JA829J
NTSB No.	:	DCA13IA037
Investigator	:	David Helson

B. GROUP MEMBERS

Group Chairman	Joseph Panagiotou	NTSB
Member	Harry Webster	FAATC
Member	Matthew Anglin	Boeing

C. SUMMARY

On January 7, 2013, about 1021 Eastern Standard Time, smoke was discovered by cleaning personnel in the aft cabin of a Japan Airlines (JAL) Boeing 787, JA829J, which was parked at a gate at Logan International Airport, Boston, Massachusetts. About the same time, a maintenance manager in the cockpit observed that the auxiliary power unit (APU) had automatically shut down. Shortly afterward, a mechanic opened the aft electronics and equipment (EE) bay and found smoke and flames coming from the APU battery. No passengers or crewmembers were aboard the airplane at the time, and none of the maintenance or cleaning personnel aboard the airplane was injured. Aircraft rescue and firefighting responded to the battery fire, and one firefighter received minor injuries. The airplane had arrived from Narita International Airport, Narita, Japan, as a regularly scheduled passenger flight operated as JAL flight 008 and conducted under the provisions of 14 *Code of Federal Regulations* Part 129.

D. DETAILS OF THE INVESTIGATION

The on-scene fire investigation began on the morning of January 8, 2013. The investigation focused on the documentation of the condition of the APU starter battery and the area within the aft EE bay where the battery was installed. Interviews with some of the first responders on scene were also conducted. Based on the physical evidence observed during the examination and due to the early suppression of the flames by the JAL mechanic

and the follow-on suppression activities by the fire department, this event resulted primarily in a smoke and heat event with the origin in the APU battery.

a. APU Starter Battery Assembly

The battery box lid (Figure 1) had a bulged appearance and was creased from corner to corner, resulting in an “X” crease pattern. The corners of the lid, by construction, were not sealed but instead butted up to each other. Due to the bulging and deformation of the lid, the corners had spread, leaving a small gap (Figure 2). The right rear corner of the lid exhibited more soot/charring/residue than the rest of the lid. The lid gasket was largely consumed, with a 5-inch piece remaining. Residue tracks on the external sides of the battery box indicate liquid dripping down the sides from lid/box interface and, in particular, the corners. The lid screw eyelets (tabs) pulled out on the sides and back, but remained intact on the front. The front two screws were removed by the fire department’s responders.

The battery consisted of eight cells, connected in series, and all appear to have vented. There was heavy charring on the tops of the cells with what appears to be the heaviest charring at the right rear corner (A/C[1] left) as viewed from the front (Figure 3). The circuit boards were charred and soot-covered, but physically intact. The internal battery management sense wires were charred but intact. The BPA[2] thermoplastic polyester sheet that covers the top of the battery cells inside the battery box was charred and melted due to thermal exposure.

Forward areas of the sides and front of the battery box were kinked, consistent with forceful removal from the aircraft during the fire department’s emergency response. The battery angle mounts on each side of the battery box were forcefully ripped from the sides of the battery box during removal by fire department personnel, shearing the rivets. The angle mounts were still attached to the aircraft. The blue paint on the external battery box was mostly intact, with some areas of charring and soot, primarily on the A/C left sides and back. The A/C right side of the battery had few indications of thermal damage (Figure 5). The A/C left side of the battery box had paint thermally consumed in a spot consistent with the location of a cell vent port (Figure 6). The aft face of the battery box had an unusual feature, a small roughly circular nodular protrusion of about a quarter inch in diameter of what appears to be a melted metallic material, surrounded by a round and concentric area of discoloration (Figure 7).

The external surface of the bottom of the battery box (Figure 8) exhibited some black staining on the A/C left side of the box. On the forward corner of the A/C right side of the battery box bottom, there was an area of damage consistent with the use of a prying tool.

The front battery J3 disconnect latch was melted and inoperable. The front J1 cannon plug connector was also melted (Figure 4).

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[1] A/C refers to aircraft and is intended to denote the orientation when standing in the aircraft when facing towards the flight deck

[2] Bisphenol A (IUPAC designation 4,4'-(propane-2,2-diyl)diphenol).

b. Battery Installation Location in Aft EE Bay

The damage to the aircraft appears to be caused by heat generated from the battery box during the event, and smoke, hot gases, and electrolyte discharged from the battery during the event. Based on interviews with the first responders (JAL mechanic and airport fire department), the only flames observed during the event were observed by the JAL mechanic, and were two approximately 3 inch flames originating from the two front connectors on the battery (Figure 4). Hot liquid was observed by the first responders oozing from the battery box during the event, shown in Figure 9 on the panel located underneath where the battery was located. Evidence of material expelled from the battery can also be seen in the areas behind the battery in the form or residue and thermal damage.

The compartment where the battery was located showed signs of heat damage, sooting, and liquid and gas release from the battery. Figures 9 through 32 show specific locations of damage.

c. First Responder Observations

Full interview notes are part of the Survival Factors/ARFF field notes. This section contains comments of interest to the fire group and may not be in chronological order.

Interviewee: Mark Munroe (Captain, Engine 5)

- Call was placed for smoke in the A/C cabin
- No obvious smoke on exterior upon arrival
- Inside the A/C there was no smoke in flight deck area, but heavy smoke in the aft portion of the A/C, smoke billowing up from floor
- Starter battery quick disconnect was fused and difficult to access due to kick plate
- Battery was sizzling
- Battery appeared to go through cycles of “rekindling”
- Battery hissing loudly and forcefully projecting smoke which was followed by a strong pop.
- Liquid flowing down the sides of the battery box
- Never saw flames during his entire time on scene

Interviewee: Joe Doherty (firefighter)

- First firefighter to apply Halotron® (American Pacific Corporation, Las Vegas, NV) to the battery
- Saw a “glow” about the size of a softball on the front face of the battery box
- Applied a strong burst of Halotron to glowing area
- Using a thermal imager he said that the area of origin appeared like “spilled flowing candle wax” and not a sharp outline of a rectangular object

Interviewee: Sato (JAL mechanic)

- First to find fire
- Used the ammonium phosphate 20lb fire extinguisher obtained from beneath the jetway
- Saw two distinct flames on the front face of the battery box
- These two flames were 2-3 inches long

Joseph Panagiotou
Fire & Explosion Investigator

Figure 1: Top down view of battery assembly with lid in place.

Figure 2: Battery box lid showing deformation, creasing and open seam where the lip edges butt together.

Figure 3: Top down view of battery assembly with separated lid set aside.

Figure 4: Side of battery box with electrical connectors.

Figure 5: A/C right face of battery box.

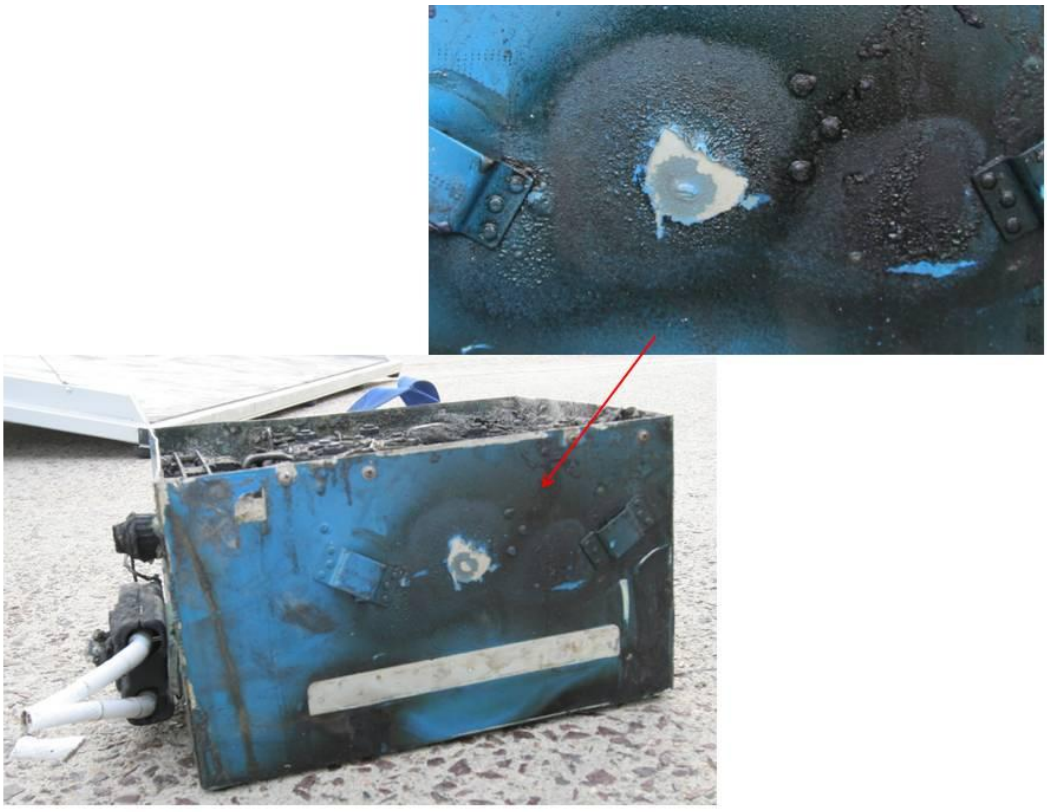

Figure 6: A/C Left face of battery box with inset photo showing area of concentrated thermal damage.

Figure 7: Aft face of battery box with inset photo showing area of concentrated thermal damage.

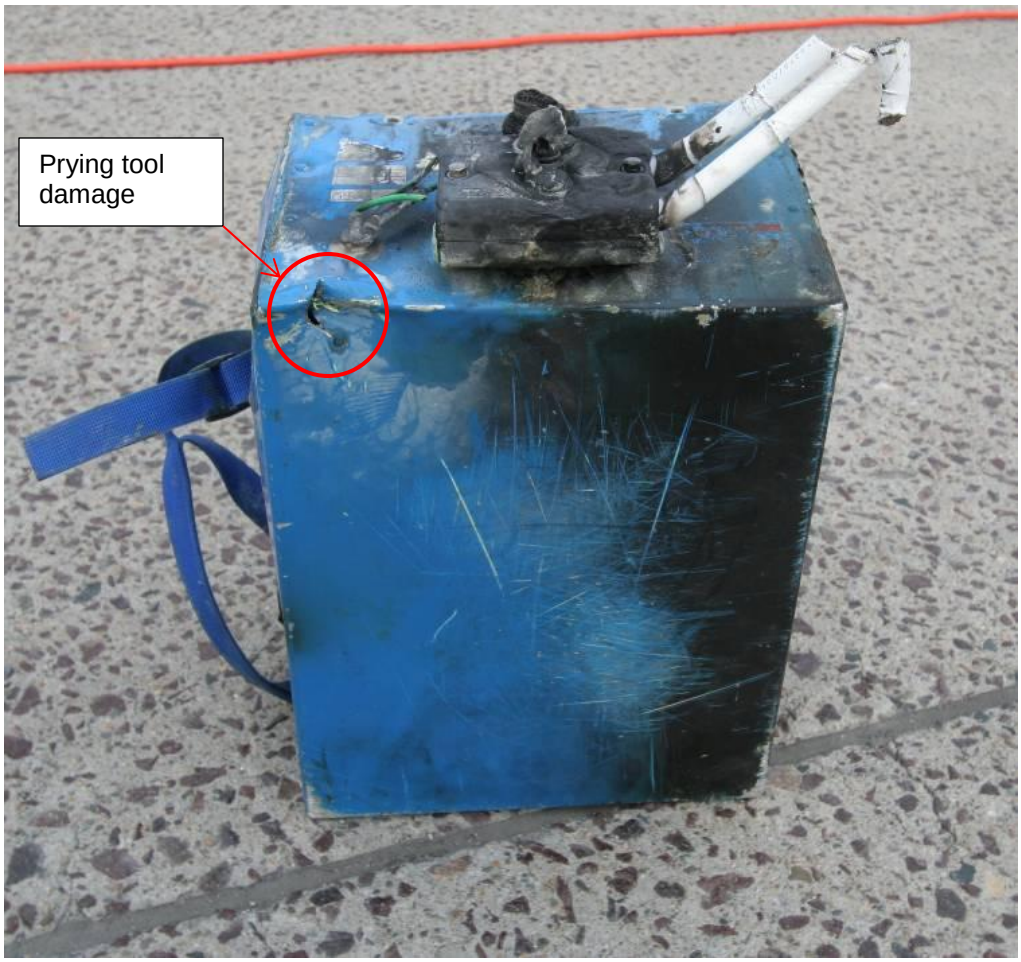

Figure 8: Bottom surface of battery box.

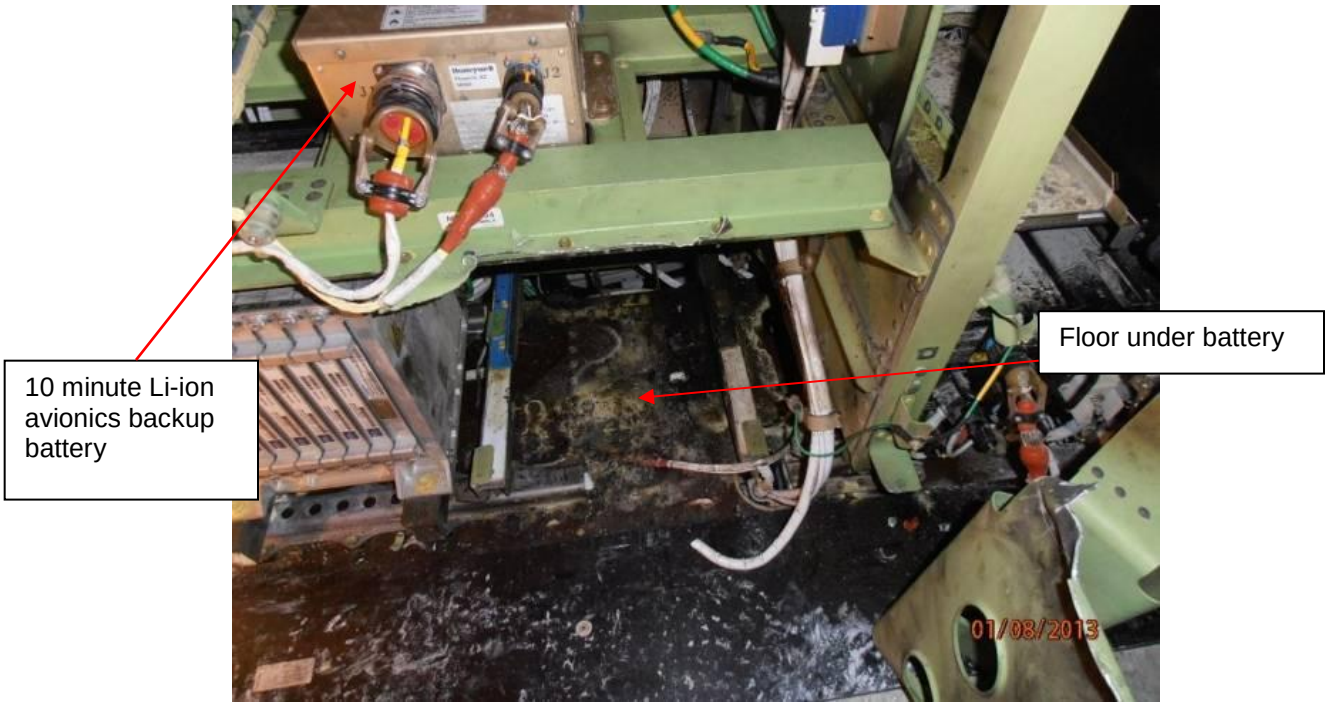

Figure 9: Battery compartment, facing aft in EE bay, after battery removal.

Figure 10: Close up view of battery compartment in aft EE bay.

Figure 11: Battery compartment, facing aft, looking upwards.

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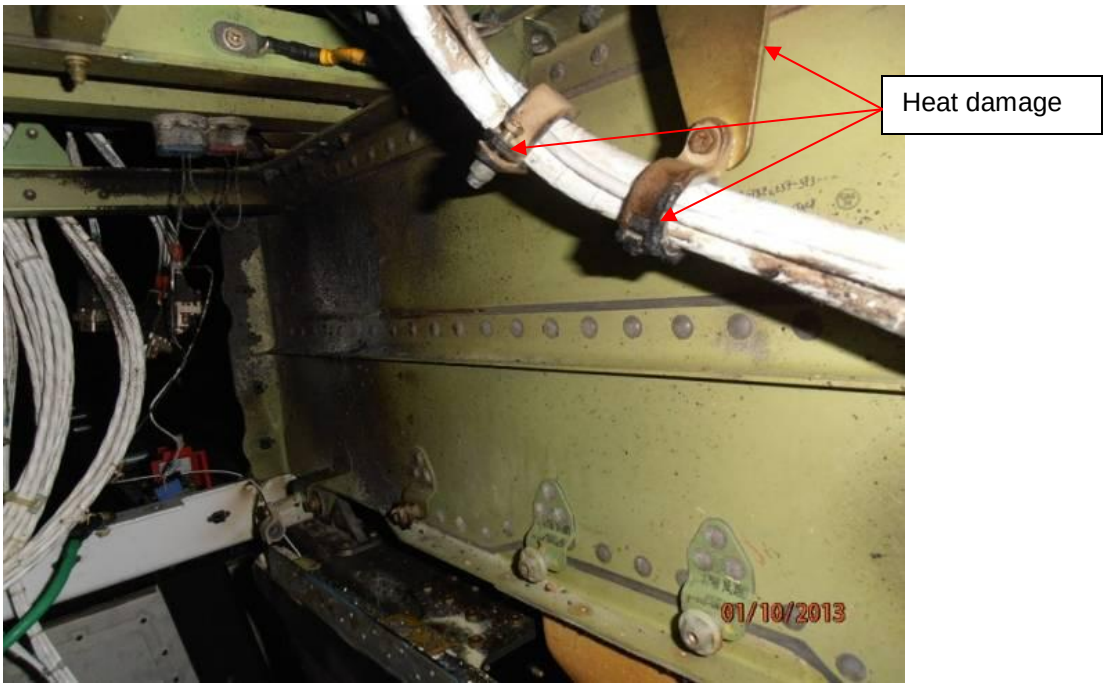

Figure 12: Thermal damage to wiring and clamp on A/C left side of the battery.

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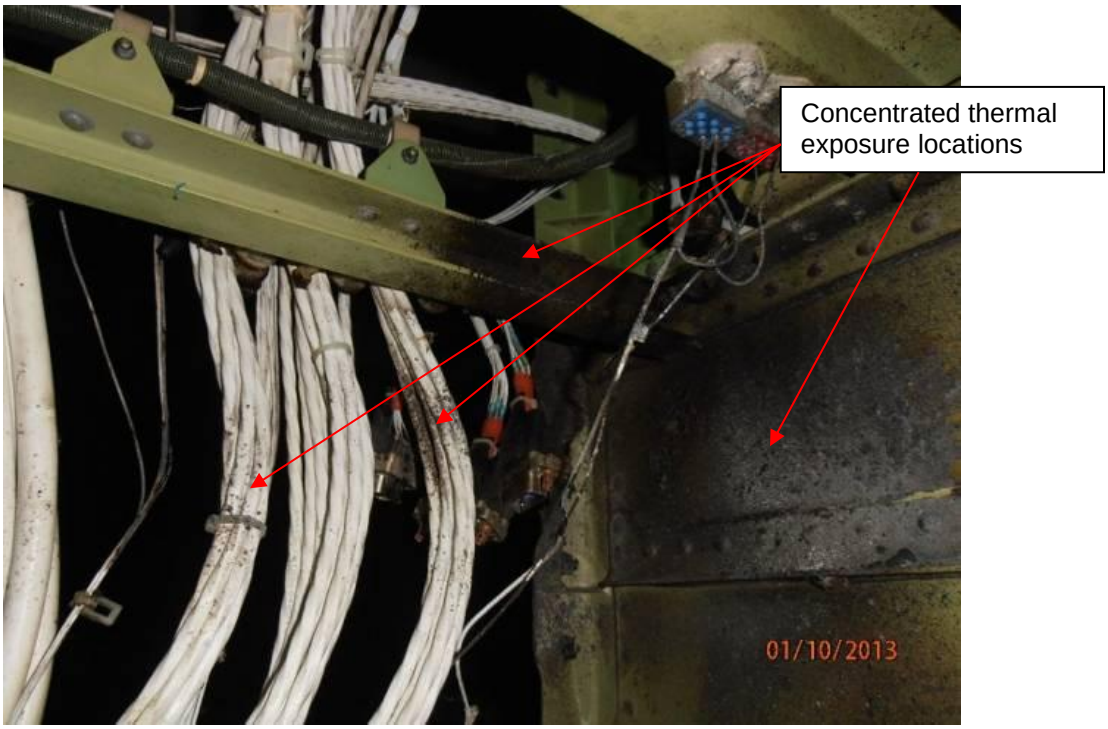

Figure 13: Close-up of battery electrolyte and smoke spray up to the A/C left behind the battery.

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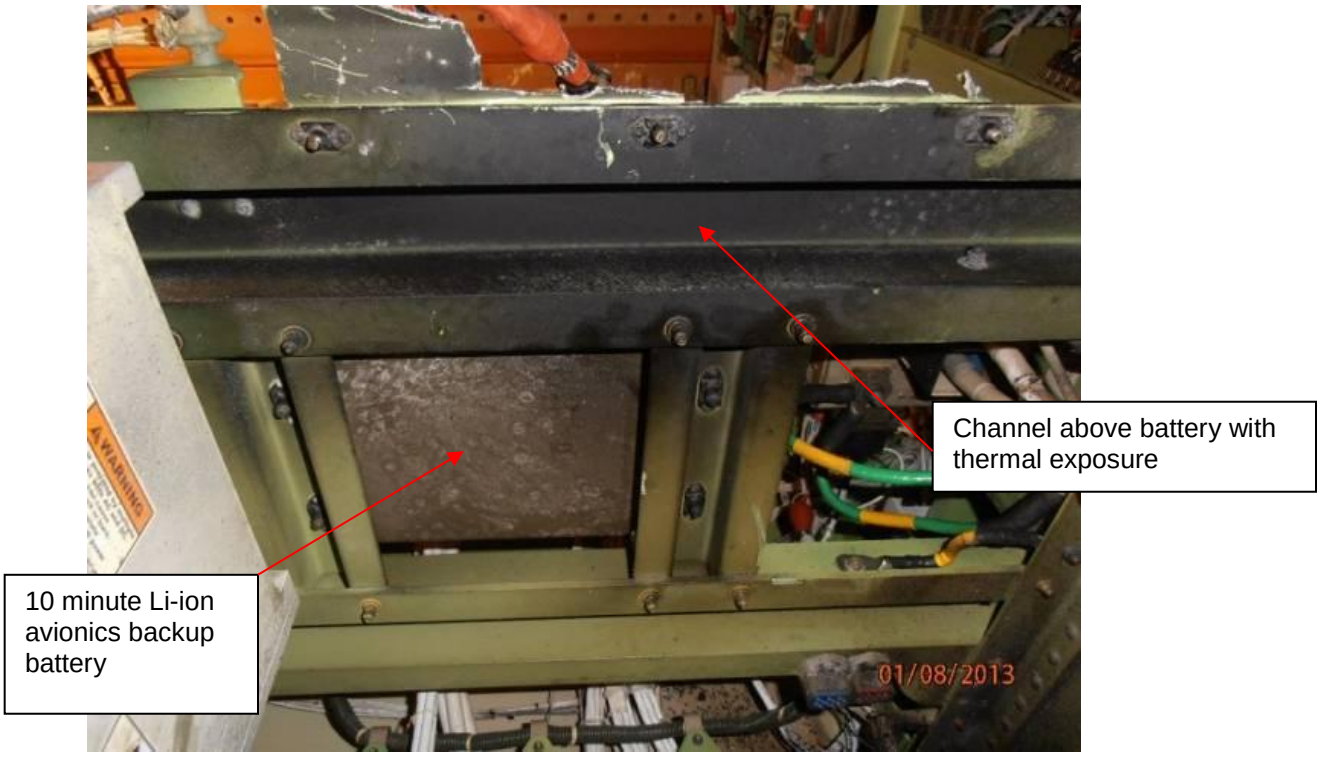

Figure 14: View looking up above battery location

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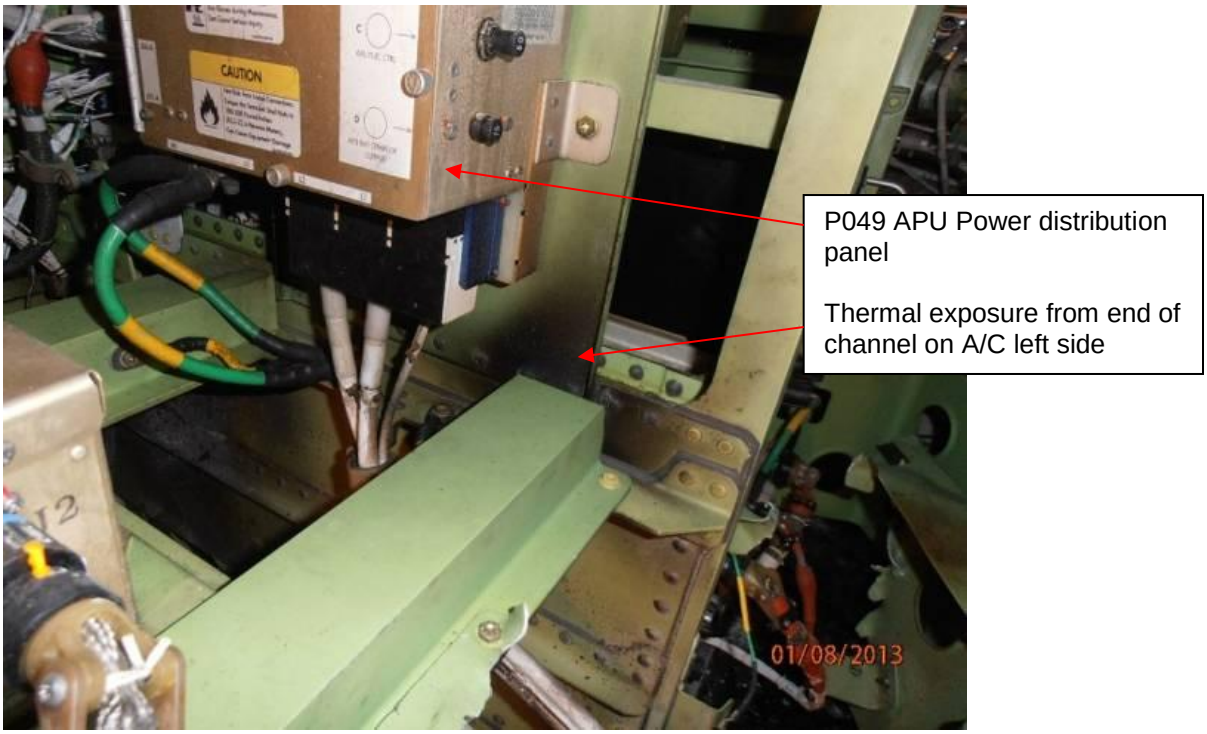

Figure 15: Top side of channel shown in figure 14

Figure 16: A/C right side of channel looking aft

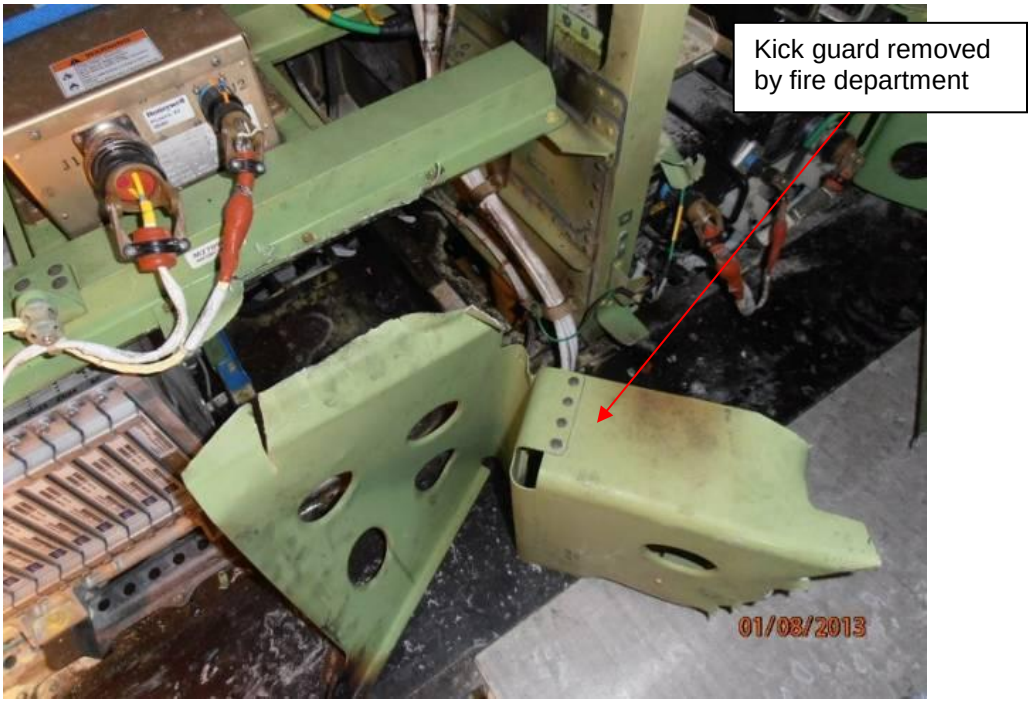

Figure 17: Kick Guard in front of battery compartment

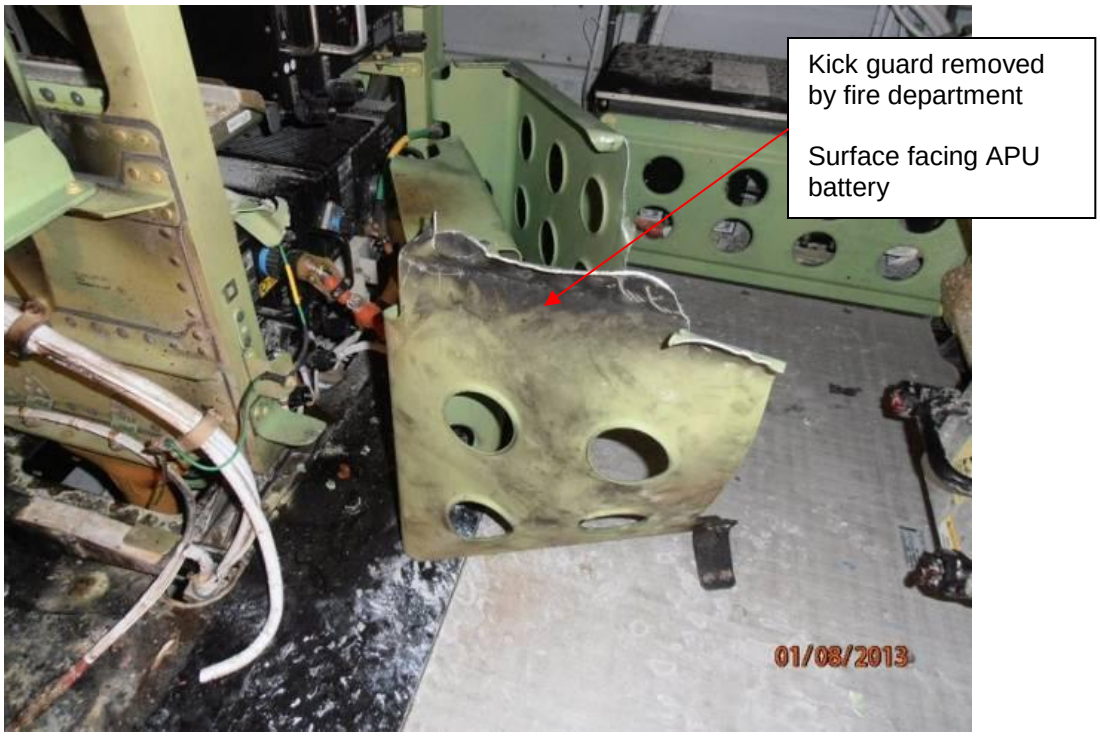

Figure 18: Battery compartment protective (kick guard) shield viewing side facing APU battery.

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Figure 19: Lower face of panel underneath APU battery compartment.

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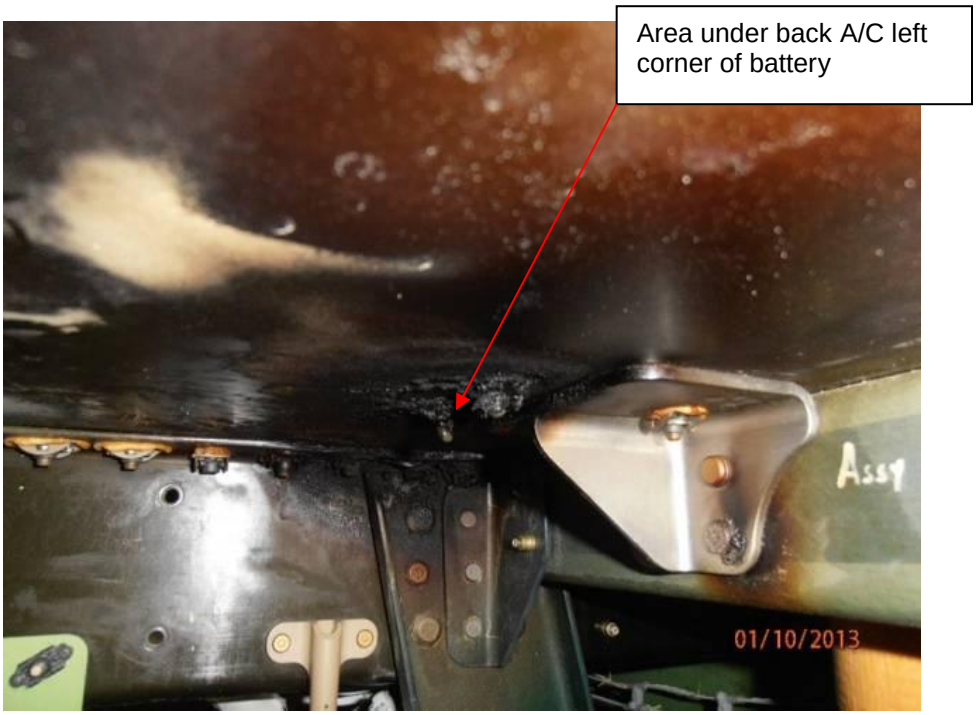

Figure 20: Close-up of photo above showing back A/C left corner under battery.

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Figure 21: Lower face of panel under battery looking up and back at A/C right side of battery.

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Figure 22: Photo looking towards back A/C right corner of panel under battery.

Figure 23: View looking up to forward A/C right corner of panel under battery.

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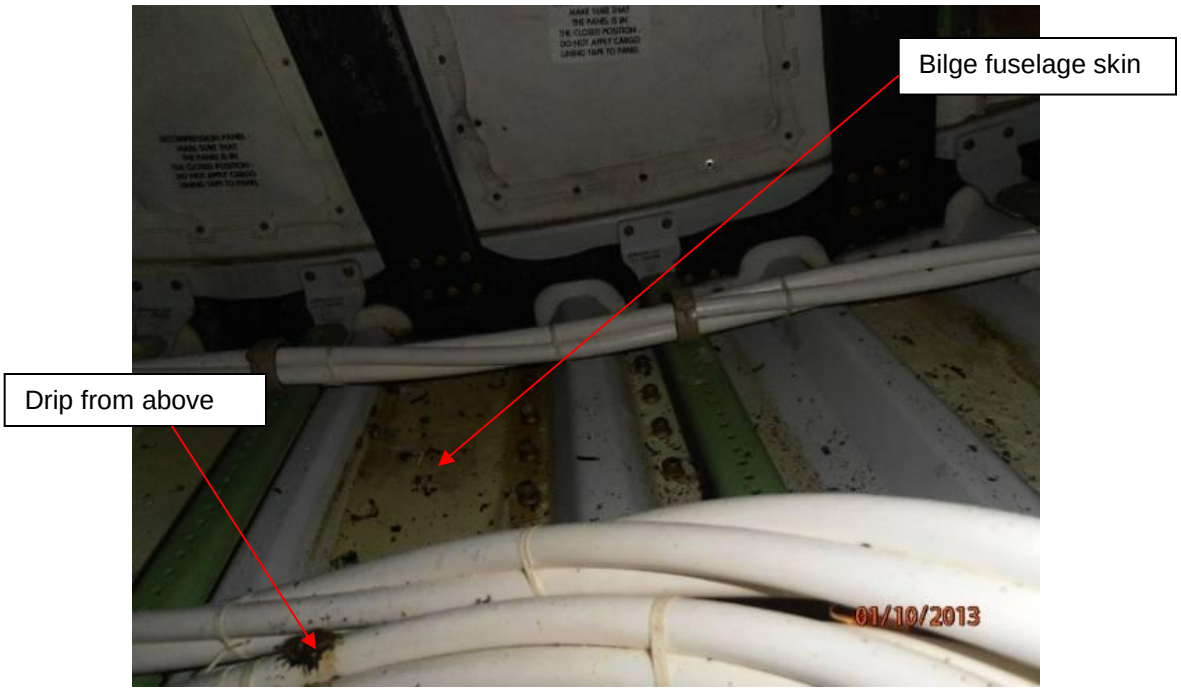

Figure 24: Bilge area under rear of battery panel.

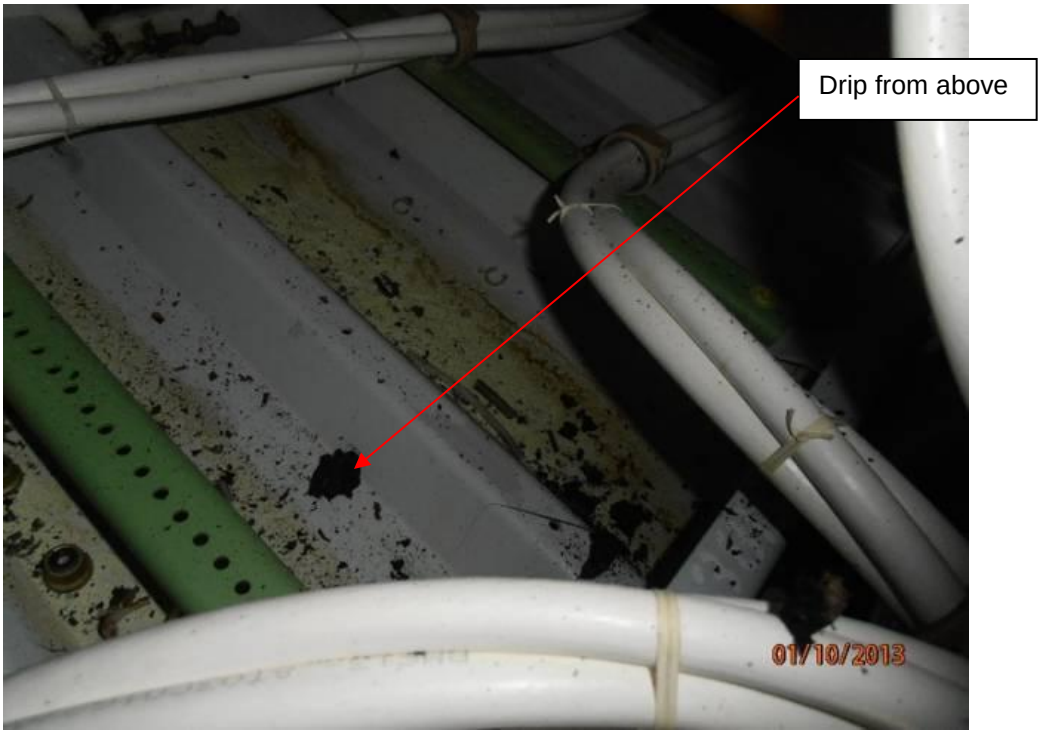

Figure 25: View of bilge area underneath and behind battery compartment.

Figure 26: Aft cargo compartment, forward cargo barrier panel, after removal.

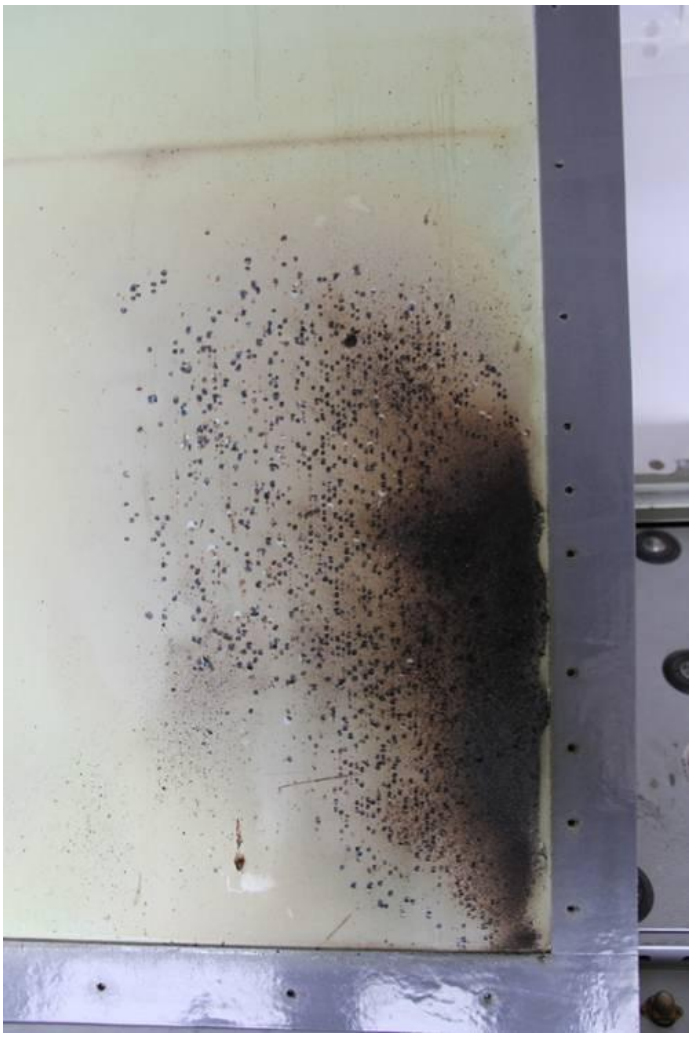

Figure 27: Close up of above view focusing on lower right corner in figure 26. The damage corresponds to the A/C left side of the battery.

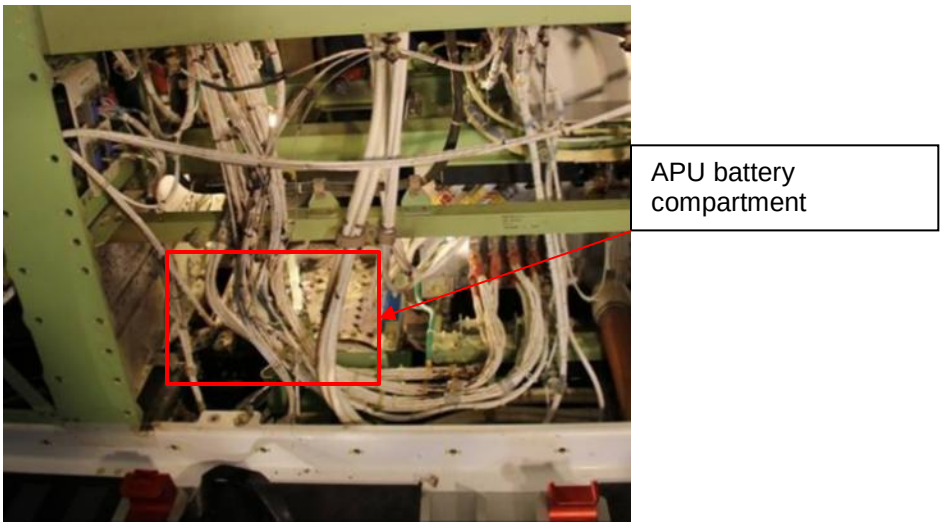

Figure 28: View of the area behind the cargo barrier panel after panel removal, view facing forward taken from inside the aft cargo compartment.

Figure 29: View of lower left of photo above, facing forward taken from inside the cargo compartment, showing spray behind and to the A/C left of the battery.

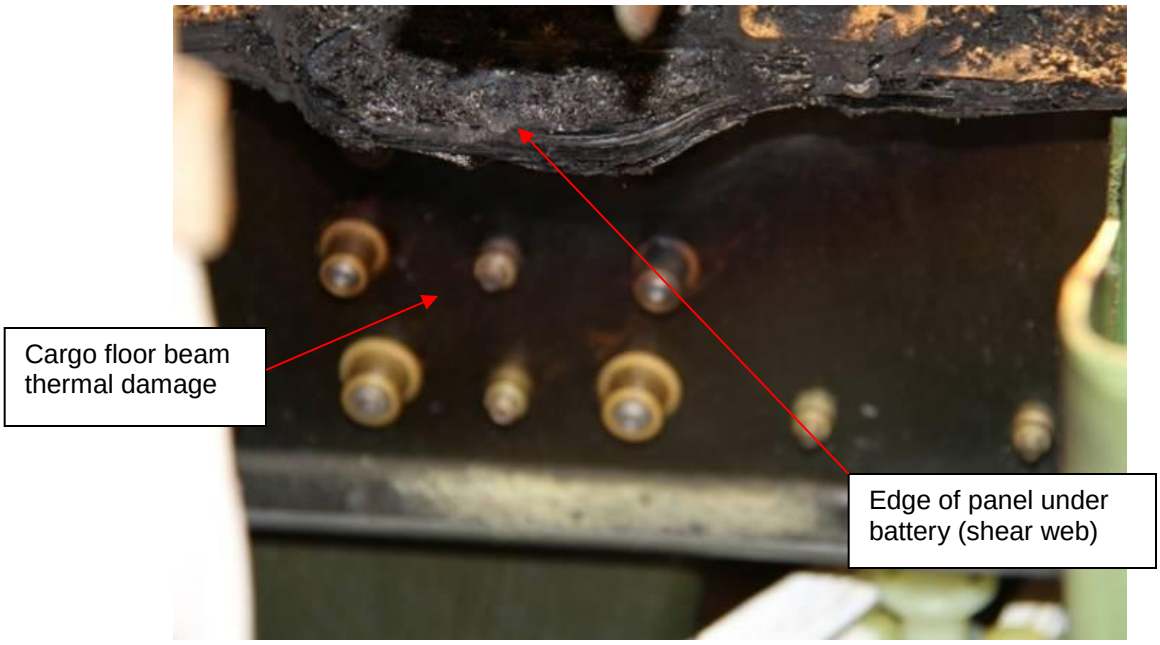

Figure 30: Rear edge of panel under back right corner of battery.

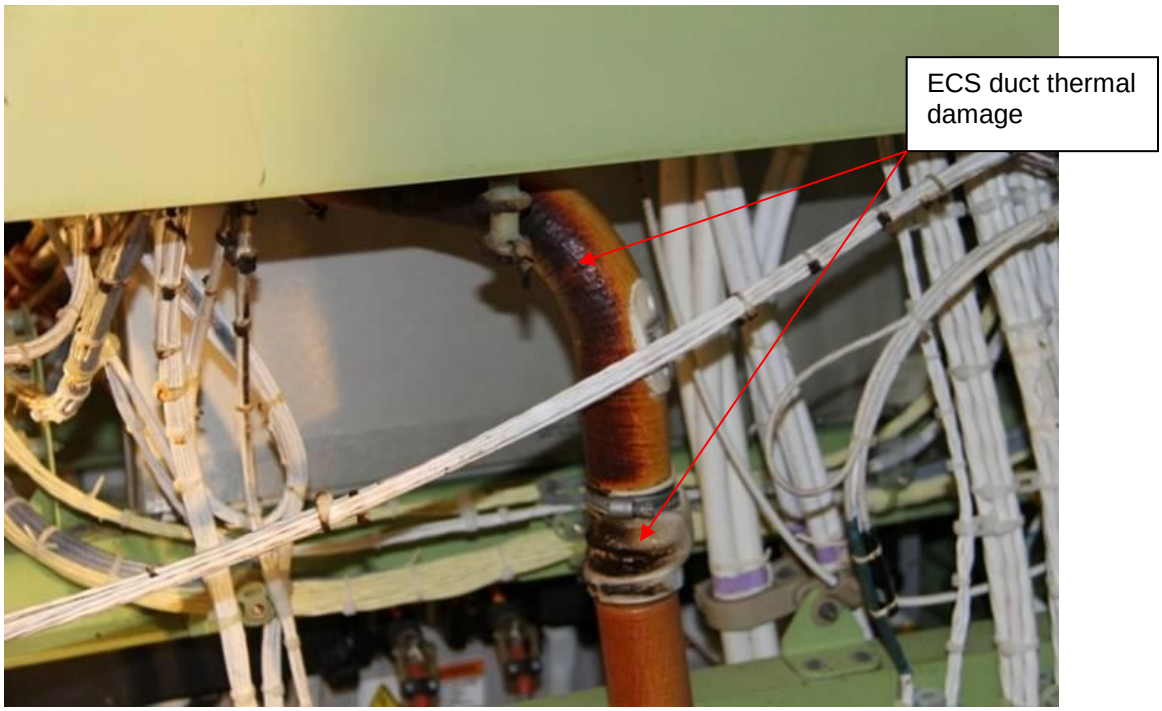

Figure 31: Thermal damage to ECS duct and standoffs. This area would be behind and above to the A/C right of the battery.

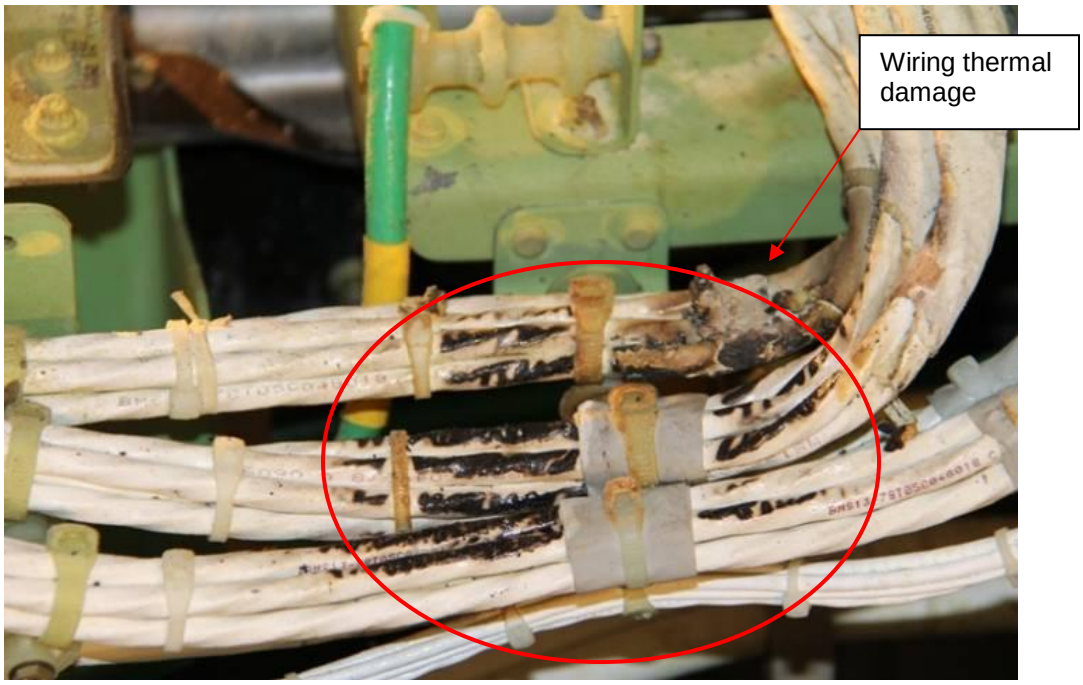

Figure 32: Thermal damage to wiring. This area would be behind and to the A/C right of the battery, below the location shown in figure 31.